i2 Technologies

Integration of i2 RHYTHM and SAP R/3

SAP CERTIFIED INTERFACE
R/3 COMPLEMENTARY SOFTWARE

WP-281

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Use of i2 Rhythm® for demand/supply chain management and optimization in conjunction with the transaction processing capabilities of SAP® R/3® provides a return on information that can be measured in terms of throughput, inventory, lead time, delivery performance, responsiveness to change, and operating expense. Functions available with the RHYTHM family of products include:

- Simultaneous constraint-based planning of material and capacity
- Variable granularity of planning (down to seconds)
- Multi-plant coordination of production and material flow
- Decision support functions such as identifying the impact on sales orders of material or capacity constraints in the production plan
- Global optimization using advanced artificial intelligence techniques and mathematical programming algorithms

To take advantage capabilities such as these, SAP and her APS partners have developed several open interfaces to R/3 for demand planning, distribution planning, factory planning and scheduling, and transportation scheduling. These interfaces provide suitable functionality for some environments. Integration functionality contained in these interfaces will continue to be used by i2 whenever available and appropriate. However, the open interfaces tend to lack net-change capabilities and tend to make restrictive assumptions regarding functionality and scope. Consequently, i2 has advanced beyond the open interfaces and developed additional integration with R/3 to:

- Meet customer requirements for a tighter, net-change integration with R/3 and
- Satisfy integration requirements for the broad scope of functionality in the RHYTHM family of products.

As a result of this development, RHYTHM is more tightly integrated with R/3 than any other APS product. The real-time integration that i2 has developed with R/3 allows RHYTHM to optimize on the latest transactional information collected by R/3 when a transaction in R/3 requires immediate attention in the planning domain. The integration also enables RHYTHM decision support during an R/3 transaction via synchronous remote function calls, which is an unprecedented level of synchronization between RHYTHM and R/3.

Scope of Integration Development

The scope of integration development includes all of i2's products for:

- Demand Planning
- Supply Planning
  - Factory Planning
  - Master Planning
  - Distribution Planning
  - Transportation Planing
- Sales and Distribution
  - Order Promising / Demand Fulfillment
  - Vendor Managed Replenishment

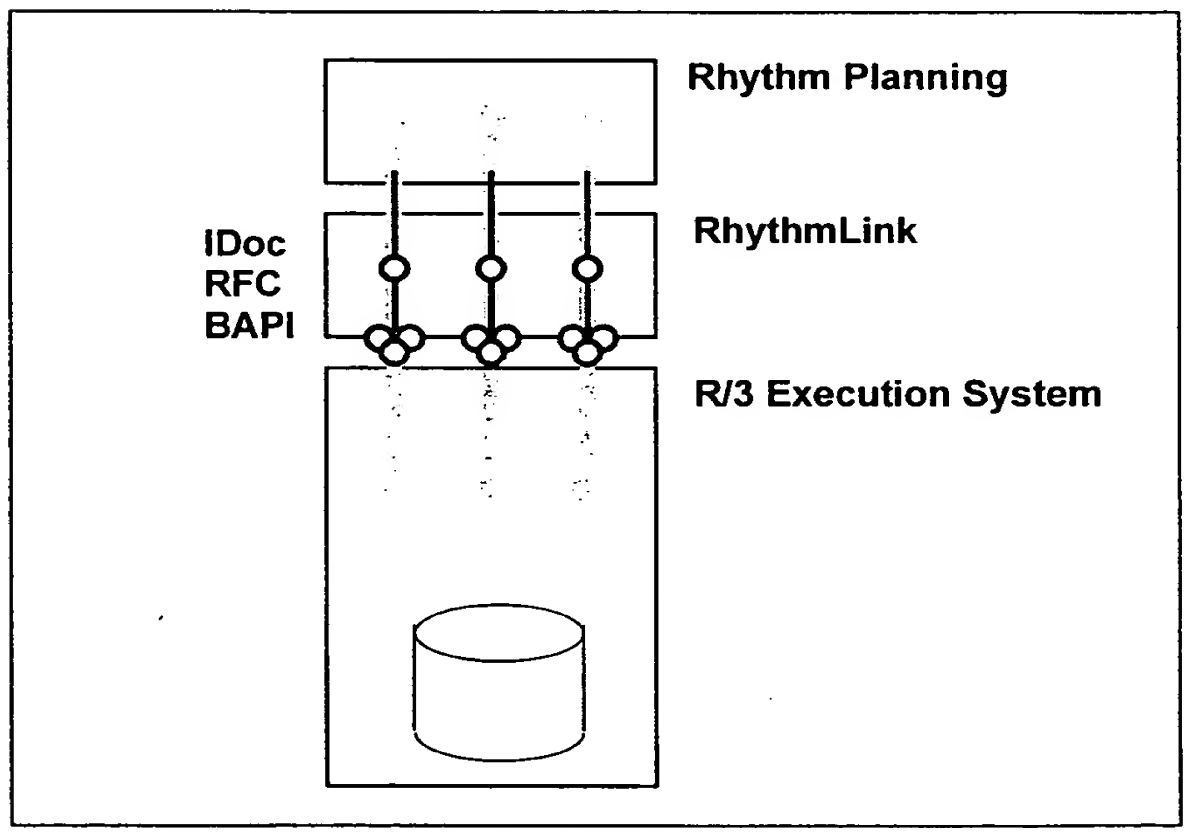
RHYTHM interacts primarily with the MM, SD, and PP modules of R/3. RHYTHM has been designed to perform planning and optimization functions like demand management, order promising, material assignment, load smoothing, deployment and shipment planning. R/3 has been designed to perform on-line transaction processing and execution functions like financials, sales order entry, tracking of inventory balances, and execution of shipping. The integration between RHYTHM and R/3 uses each system according to the purpose for which it was designed.

RHYTHM users benefit from a system that provides very fast advance warning of constraints in their supply chain. Constraint resolution is enabled by full pegging, very fast reassignment of material and capacity, and bi-directional propagation and synchronization both horizontally and vertically. Recommended actions to remove constraints are generated automatically. Plans can be made visible to as much of their enterprise or supply chain as desired.

Many industries (e.g., metals, semiconductor, paper, textile, automotive) have unique requirements or complex manufacturing processes that prevent them from utilizing the R/3 PP module. With Rhythm's open architecture and RhythmLink's ability to communicate with legacy applications, non R/3 systems may take the place of R/3 anywhere they provide needed functionality. Often this is in the area of shop floor control and WIP tracking

RhythmLink-Based Integration with SAP R/3

i2's RhythmLink product acts as a data conduit between RHYTHM and R/3. Field bindings in RhythmLink define the mapping between the various data sources (such as BAPIs, IDocs, or RFCs) to RHYTHM objects and vice versa. Bindings are defined with an intuitive drag-and-drop editor. RhythmLink contains a variety of other features necessary for easy integration, such as capabilities to filter data based on criteria and to join data from different data sources. RhythmLink has been designed for maximum throughput. Filters, joins, aggregations, net-change operations, and bindings are all executed in memory. When possible, these functions are pushed back to the data source for execution, leveraging performance features built into tools such as database management systems.



Three different degrees of integration are provided between R/3 and Rhythm. The appropriate technology to exchange each data item depends on the frequency with which the data changes and the speed with which it must be transmitted in order to create and execute accurate plans.

- Periodic, asynchronous exchange of data

  The period may be 1 week or 15 minutes, as appropriate to the situation. The data exchange may be a full refresh or only data that has changed since the last exchange. Master data would normally be exchanged in this manner. The technologies used for this type of exchange are ALE, IDoc, and tRFC. With R/3 4.0 asynchronous BAPIs also could be used.

- Event-triggered, asynchronous exchange of data

  This approach is used when immediate visibility of transactional data in the planning engine is important, e.g. high-priority sales orders. This approach includes exchange of data on-request. The technologies used for this type of exchange are ALE, SAP Business Workflow, asynchronous BAPI, IDoc, and tRFC.

- Automatic, synchronous exchange of data

  This approach is appropriate where a decision support function provided by RHYTHM is being used within an R/3 transaction. The technologies used for this type of exchange are sRFC or synchronous BAPI.

Application Link Enabling and IDocs

SAP's Application Link Enabling (ALE) technology is one method used to exchange data between R/3 and Rhythm. ALE is used to link distributed R/3 and R/2 systems with one another and with external applications. Using ALE, IDocs (intermediate documents) containing master data and/or transactional data are sent from R/3 to RHYTHM over either an intranet or the internet.

IDocs have a hierarchical structure that is understood by RhythmLink. Each IDoc type in R/3 (Material Master, Routing, etc.) contains meta data that defines the specific structure of the segments and fields in the IDoc. New meta data or a completely new IDoc type? No problem. Unlike other packages, RhythmLink reads this meta data directly from R/3, so if new IDoc types are defined or if the structure of an existing IDoc type is changed, these changes will be reflected automatically in RhythmLink. This feature allows users to modify and extend the integration between RHYTHM and R/3 without programming and is quite convenient during interface design.

Typically a RhythmLink event would be defined to process each IDoc type. Using RhythmLink events, a message and its associated data are received at the same time, allowing true real-time synchronization between sender and receiver. When an event is triggered (e.g., the arrival of an IDoc), event instructions are processed. The instructions are defined with RhythmLink's easy to use point-and-click GUI.

Remote Function Calls

Interprocess communication is performed via SAP's Remote Function Call (RFC) facility. Synchronous RFC's (sRFC) are used for the direct exchange of data between processes. Also, the transmission of data contained in IDocs is technically accomplished with transactional RFC's (tRFC).

RhythmLink provides a unique way to define RFC's. Normally an RFC would be written in a compiled programming language such as C or VisualBasic and would require a recompilation whenever changes are made. The name, arguments, and implementation of the RFC would be specified within the program. Changes would be painful to make because everything is hardcoded. Instead of this fixed approach to implementation, RhythmLink takes a meta-layer approach. RFC definitions are modeled in RhythmLink such that they are data-driven and hence are end-user configurable. RFC definitions include the RFC name, import and export parameters, tables, and also the implementation. These are all defined in RhythmLink without programming (stored procedure, event, data copy map), and users can make adjustments to the integration when business processes change.

By incorporating synchronous remote function calls (sRFC) into user exits in R/3 transactions, RHYTHM provides seamless on-line decision support during those transactions that require decision support. For example, RHYTHM provides real-time calculation of feasible due dates during the order entry process in SD. Constraints are viewed concurrently during the decision making process to make optimal or intelligent decisions in real-time.

BAPIs

BAPI's (Business Application Programming Interfaces) defined by SAP are utilized when they are available and appropriate. BAPIs are methods of business objects in the R/3 system (internally, a BAPI calls an R/3 function). BAPIs support the RFC protocol at this time, so from RhythmLink's perspective the BAPIs are simply an additional set of RFCs that can be called to exchange data. In the future when a DCOM interface to BAPIs is available, this will be used. Prior to Release 4.0 of R/3, BAPIs can only be processed synchronously. With Release 4.0, asynchronous BAPIs are available. Asynchronous BAPIs use IDoc messaging technology, i.e. an IDoc is used as the data container when the BAPI is called.

Summary

When unique data requirements of a particular implementation have not been anticipated, the capabilities of RhythmLink to read IDoc meta data directly from R/3 and to define and implement RFC's in a data-driven manner allow users to modify and extend the integration without programming.

The integration of RHYTHM and R/3 uses the same techniques that are used within R/3 systems for integration. Standard SAP concepts, approaches, and technologies are used that will be maintained in future releases. Consequently, this integration truly is designed for the long term, and implementations of the integration can be made with confidence.

Objectives of Integration Development

The following objectives guided the development of the integration:

- Use standard supported SAP integration technologies
- Provide for net-change exchange of data
- Provide for real-time data flows
- Integrate semantically at the level of business objects rather than at the level of data in order to enable seamless workflows.
- Provide for customers to be able to change and extend the standard integration if desired
- Maintain data in only one place
- Perform intelligent filtering on the sending side so as to not send unneeded or inappropriate data
- Define structure of IDocs to maximize performance
- Maintain the standard integration including the data mapping as a product

Synchronization Between Planning and Execution

The nature of the synchronization between any planning system and any execution system is influenced by three concepts: dynamic nature of plans, requirement for a planning workspace, and existence of multiple private and public plans.

Dynamic Nature of Plans. A plan is dynamic (i.e., it is changing every hour or minute) and planning is an ongoing process. The plan reflects future activities and is dynamically adjusted based on changes in the current environment (e.g., a forecast quantity changes, a sales order due date changes, a WIP confirmation is recorded, or a supplier delivers a short quantity).

Planning workspace. A planner needs to perform various what-if analyses and examine various possible alternatives before committing to a plan and publishing it to the enterprise. When interactive planning is being performed, a planner also needs to control when new data is added to the plan so that the impacts of adding the new data are not confounded with the results of planning decisions that he is making. Consequently, the planning system needs a workspace in memory in which to operate that can be temporarily insulated from the data chatter created by on-line transaction processing. The need for the planning system to have private planning workspace is a functional requirement, not a technical limitation.

Multiple private and public plans. More than one plan can exist. Some of the plans may still be in a working state and are not fully feasible or optimal. Hence, the planner needs the ability to designate some plans as public and others as private. Public plans are visible in the execution system and the planning system. Private plans reside only in the planning system. Typically there will be one public plan that is released to the enterprise (sometimes referred to as the plan-of-record) and one or more private plans for various what-if scenarios. When several plans are public, one is designated as the primary plan and others are alternate plans.

The design of RHYTHM and the design of the integration between RHYTHM and R/3 reflects these concepts. Complete flexibility is provided for the exchange of data, both for the scope (net-change or complete) and the frequency (on-request, periodic, event-triggered, or automatic).

RhythmLink (specifically, the RL_SAP Client) listens for messages that are sent from R/3 application servers. It imports these messages containing the current status of the supply chain into the RHYTHM planning engine. Different business objects may be imported into the RHYTHM engine with different frequencies. For example, changes in demand (including new demand) may be imported with a higher frequency and changes in routings may be imported with a lower frequency. Messages from R/3 may be sent on-request, periodically, on an event-triggered basis, or automatically when data is posted. Normally a planner performing interactive planning would import planning data on a very frequent basis but at points in time that he decides. Alternatively, he may want to setup a regular schedule for importing data that matches his normal work routine. A planner might also want to define events that will update the planning model automatically (e.g., creation of a high priority sales order in SD). In some environments the planner may desire that every change is immediately brought into the planning engine, but this may be computationally expensive and of no business value.

Publishing is the process that makes a plan available to the enterprise. In R/3, the published plan is contained in planned orders, production orders, purchase requisitions, purchase orders, stock transfer requisitions, stock transfer orders, and sales orders. Currently R/3 is not able to accept multiple public plans except in the SOP area where versions may be used. The frequency with which the plan is published in R/3 may be on-request, periodically, on an event-triggered basis, or automatically. Normally a planner performing interactive planning would publish planning data on a very frequent basis but at points in time that he decides. If the plan is published periodically, the planner should ensure that the plan is sufficiently feasible at the times it is published. A planner might also want the results of certain planning decisions to be published automatically. In some environments the planner may desire that every change is published immediately but this is not typical.

Appendix. Overview of i2 Technologies

i2 is committed to providing its customers the highest levels of customer responsiveness at lowest cost through intelligent management of the enterprise supply chain.

Quantifiable Results to the Customer

Our value-focused approach to business has consistently enabled us to provide "game-changing" solutions that deliver measurable results for our customers. These customers have achieved significant benefits using RHYTHM including:

- ↑ Throughput 2-5%
- ↓ Planning Cycle Time 95%
- ↓ Inventory 60%
- ↓ Operating Expenses 10-50%
- ↓ Order Lead Time 10-40%
- ↓ Late Orders 25-50%

The business value of these operational measures and benefits have a direct impact upon our customers' financial position. They typically include:

- ✓ IRR > 500%
- ✓ ROS increase up to 1.5%
- ✓ ROA increase up to 4%
- ✓ Payback period < 12 months

The Supply Chain Management Opportunity

A supply chain can be defined as a collection of business entities or assets involved in the flow of products from raw materials procurement, through manufacturing and logistics, to delivery of finished goods to customers. Market trends such as demand variability and volatility, global competition, and faster time-to-market pressures are forcing enterprises to better manage their supply chains. Today's level of competitiveness requires that product quality is a given and considered cost of entry to a manufacturer. Customer service and flexibility represent the new competitive advantage for business success.

The business challenges confronting companies in managing a supply chain include:

- Transfer of logistics responsibility from retailers to manufacturers via techniques such as Vendor Managed Inventories (VMI)
- Increasing emphasis on 100% service levels
- Increasing product variability and configurations
- Shortening product life cycles and accelerated obsolescence
- Increasing Engineering Change Requests (ECR)
- Marketing promotions
- Logistics and transportation costs
- Packaging
- Consolidation and Cross-Docking
- Shelf life of products

The above trends place enormous pressure on businesses to effectively manage their supply chains in order to meet their revenue, market share, and profitability goals.

An Innovative Approach to Planning

In order to create an intelligent software solution that meets the needs of today's supply chain management challenges requires a different approach to planning. Given this perspective, i2 has introduced some concepts that can be considered fundamental to managing a highly dynamic and equally responsive supply chain.

Concurrent Planning. Unlike traditional planning systems that take a sequential approach to planning, RHYTHM plans an enterprise's operations concurrently, looking at material, capacity, distribution, and transportation simultaneously for a plan that is "globally good" for all parts of the enterprise. Concurrent planning eliminates the iteration that arises in a sequential process. In a sequential process, a planning decision is made, computations are performed, exception messages are created, and planning decisions are remade. By providing a concurrent view of all constraints, an intelligent decision is made in one step.

Constraint-Based Planning. The performance of any system is limited by its constraints. Therefore, in order to efficiently meet customer demand, it is critical to plan and schedule around the constraints within the system in order to achieve desirable throughput rates, lower inventory and operating expenses, and maximize due-date performance. RHYTHM enables a business to be more responsiveness to the customer by identifying the constraints and anchoring plans and schedules around them. Based upon these constraints, RHYTHM automatically generates feasible plans that are both material, capacity, and resource-optimized throughout the supply chain.

Global Rather Than Local Optimum. RHYTHM is designed to handle multiple constraints from the global viewpoint: *What is best for the enterprise supply chain as a whole?* By taking a holistic approach, RHYTHM calculates the relationship between the individual components and the whole, paying particular emphasis to the constraints that stand in the way of achieving the enterprise operational and overall corporate goals. It is also important to understand that a global optimum cannot be achieved using a sequential planning approach.

Memory-Resident Planning and Optimization. Speed is a critical component of intelligent decision making. In many instances, the results of an MRP or DRP run are no longer valid because the initial conditions had changed over the time taken to find a solution. Since RHYTHM is entirely memory-resident, feasible solutions are generated in less than 10% of this time and "what-if" simulations are instantaneous.

Multi-Enterprise Request/Promise Capability. Rhythm's intelligent supply chain management capabilities allow multiple enterprises to exchange plans among each other. Via a sophisticated Request-Promise mechanism, different decision-making domains can negotiate with each other to create an operating plan where the local business objectives are synchronized with the overall goals of the supply chain

Appendix. Interoperability with RhythmLink

RhythmLink acts as a data conduit between RHYTHM and other applications or data sources including ...

- Relational databases (ORACLE, Informix, Sybase, DB2, etc.)
- ERP systems (SAP, ORACLE, BaaN, SSA, JD Edwards, etc.)
- Legacy and third-party applications (configuration, shop floor data collection, etc.)
- ASCII files

Data sources are accessed via middleware such as ...

- SAP (ALE/IDoc, sRFC, tRFC, BAPI)
- SequeLink
- ODBC
- CORBA

Functionality for Interface and Integration Design includes ...

- Events
- Graphical navigation through data sources
- Creation of bindings by an intuitive drag-and-drop editor
- Data filters
- Data joins
- Data aggregation
- Computation of delta's to the plan
- Data-driven RFC definitions
- Reading of IDoc meta data directly from R/3
- Industry-accepted, standard technologies. As new technologies become mainstream, RhythmLink will leverage or provide links to these technologies.